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SYNOPSIS OF BIOLOGICAL DATA ON THE BLUE WHITING

Micromesistius poutassou (Risso, 1810)

Prepared by
D.F.S. Raitt

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 1968

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y

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FAO Fisheries Synopsis No.34 Rev.1 FRm/S34 (Rev.1)
(Distribution restricted) SAST - Blue whiting - 1,48(04)033,01

SYNOPSIS OF BIOLOGICAL DATA ON THE BLUE WHITING

Micromesistius poutassou (Risso, 1810)

Prepared by

D.F.S. RAITT

Marine Laboratory
Aberdeen, Scotland

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, July 1968

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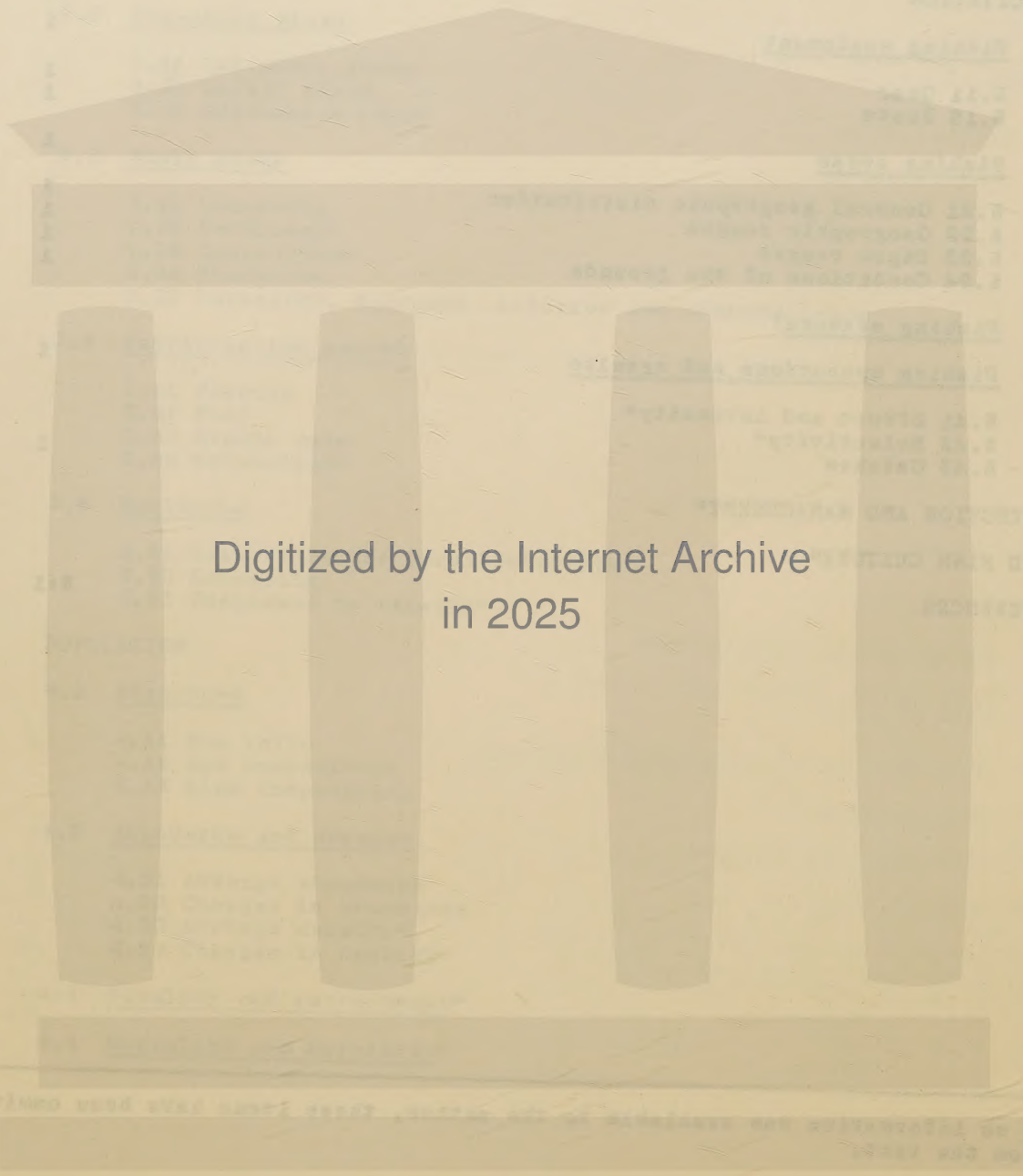
* As no information was available to the author, these items have been ommitted from the text.



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1. IDENTITY

1.1 Nomenclature

1.11 Valid name

Micromesistius poutassou (Risso, 1810)

1.12 Objective synonymy

Merlangus poutassou Risso, 1826
M. vernalis Risso, 1826
M. pertusus Cocco, 1829
M. communis Costa, 1850
Gadus melanostomus Nilsson, 1853

1.2 Taxonomy

1.21 Affinities

- Suprageneric

Phylum Vertebrata
Series Pisces
Class Teleostomi
Subclass Actinopterygii
Order Gadiformes
Family Gadidae
Subfamily Gadihae

- Generic

Micromesistius Gill, *Proc.Acad.Nat. Sci.Phila.*, (1863), 1864:231.

Genotype:

Merlangus poutassou Risso

The following generic concept is that given by Svetovidov (1948):

"The dorsal and anal fins are divided by spaces. The space between the first and second dorsal fins is greater than the diameter of the eye, space between the second and third dorsal fins is greater than the base of the second dorsal fin, beginning of the first anal fin is forward of the origin of the first dorsal. Caudal fin with a small notch. The lower jaw projects forward slightly. Barbel on the chin undeveloped. Teeth on premaxillary and dentary, 1-2 teeth on either side of the head of the vomer. Lateral line straight, running parallel with the dorsum above the midline of the body, uninterrupted for its entire length. On the head along the lateral line canal system there are pores: 12 in the preopercular-mandibular canal, 9 in the infraorbital canal, 3 in the supraorbital canal and 1 in the supraorbital commissure. The mucous cavity is closed in front. The facial nerve exits from the side of the skull through a foramen."

- Specific

Micromesistius poutassou (Risso)

Type : *Gadus merlangus* (non L.) Risso, Ichth. Nice, 1810:115

ID 12-15; IID 9-15; IIID 22-28; IA 30-42; IIA 24-30; pectoral fins 19-23; pelvic fins 6; gill-rakers 27-33 (23-26 on the lower limb of the gill arch); vertebrae 55-59, vertebrae bearing the first haemal arch 23-27. Colouration bluish-grey on back, lighter on the sides, silvery; belly milk-white; small dark spot, sometimes absent, at the base of the pectoral fin. Length to 40 cm, seldom larger. After Williamson (1908), Svetovidov (1948) and Kandler and Kieckhafer (1966). Intestine with 8-14 pyloric caeca (Raitt, 1962).

Above description based on specimens from north-east Atlantic only.

- Subjective Synonymy

Gadus merlangus Risso, 1810
Merlangus albus Yarrell, 1841
Gadus potassoa Düben, 1846
Pollachius poutassou Bonaparte, 1846
Gadus poutassou Gunther, 1862
Micromesistius poutassou Gill, 1864
Boreogadus poutassou Malm, 1877

Key to the species of *Micromesistius* (after Svetovidov, 1948)

1) 23-26 gill-rakers on the lower limb of the first gill arch, 27-33 on the entire gill arch
M. poutassou (Risso)

2) 33-39 gill-rakers on the lower limb of the first gill arch, 42-43 on the entire gill arch
M. australis (Norman)

1.22 Taxonomic status

Morpho-species

1.24 Standard common names, vernacular names (see Table 1).

TABLE 1

Standard and vernacular names of blue whiting

Country	Standard Name	Vernacular Name
Finland	Mustakitaturska	
France	Poutassou	
Germany	Blauer Wittling	
Greece	Prosphygaki	
Iceland	Kolmunni	
Israel	Shibbut qatan	
Italy	Melú	
Malta	Stokkafixx	
Monaco	Putassu	
Norway	Blåkgunnar	
Poland	Blekitek	
Spain	Bacaladilla	
Sweden	Kolmulen	
Tunisia	Navalli	
Turkey	Bakalyaro	
United Kingdom	Blue Whiting, Couch's Whiting	
USSR	Poutassou	
Yugoslavia	Ugotica	

1.3 Morphology

1.31 External morphology (see also section 1.21)

It is a typical gadoid with three dorsal and two ventral fins but can be readily distinguished by the following diagnostic features: long slim shape, absence of barbel on the lower jaw, position of vent and the wide spaces between the dorsal fins (Fig.1).

Proportional measurements:

"In percent of body length: anteanal distance 30.5-33.3, antedorsal distance 29.5-31.1, length of pectoral fin 12.4-14.6, length of pelvic fin 5.8-6.2, length of the base of the first dorsal fin 8.0-9.1, length of the base of the second dorsal fin 8.0-10.3, length of the base of the third dorsal fin 13.8-14.8, length of the base of the first anal fin 32.3-37.9, length of the base of the second anal fin 15.5-16.5, height of first dorsal fin 9.6-11.9, height of first anal fin 6.7-7.8, depth of caudal peduncle 3.7-4.9, its length 9.4-10.8, length of head 22.1-23.8. In percent of head length: length of snout 31.3-35.0, diameter of eye 25.9-28.7, length of upper jaw 40.6-43.5, length of lower jaw 54.1-57.9, width of forehead 10.5-13.5" (Svetovidov, 1948).

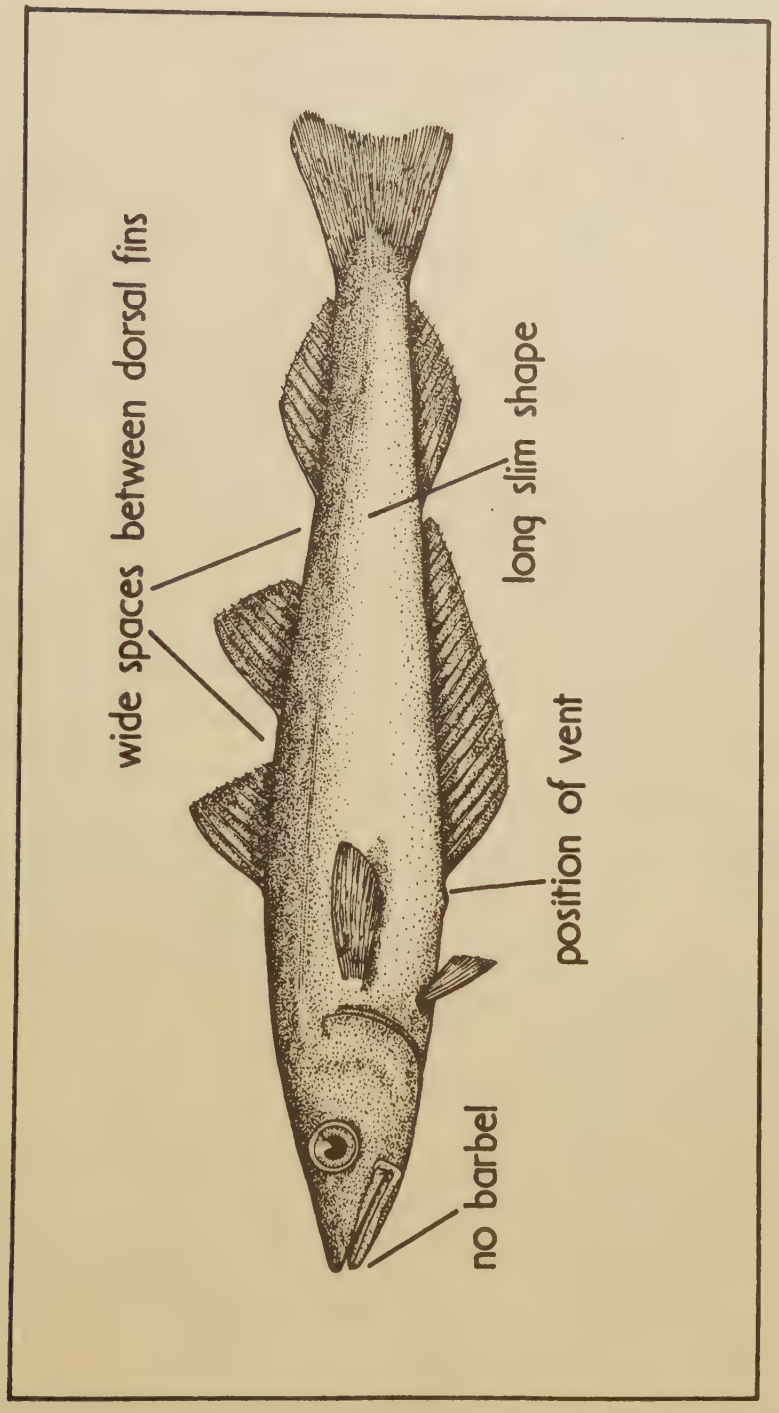

Figure 1. Blue whiting - diagnostic features

2. DISTRIBUTION

2.1 Total Area

Schmidt (1909) states that the distribution of blue whiting extends from the Mediterranean to the North Cape of Norway. It is an oceanic species and is more typically found beyond the edge of the continental shelf above depths in excess of 100 fathoms. They are also found off the south and west coasts of Iceland (Saemundsson,1949). They occur only in the deepest parts of the North Sea, mainly on the edge of and inside the Norwegian Deeps, and to a far less extent also in the north-western North Sea provided that the areas of sea-bed lie below a depth of 100 m (Sahrhage, 1964). Blegvad (1946) also records their presence in the catches of the Danish "waste fish" fishery from the Skagerrak. Wheeler (1965) and Fluchter and Rosenthal (1965) both record them from the southern North Sea. Jensen (1905) found large numbers of their otoliths in bottom deposits from the "Polar Deep" between Norway and Greenland, and Spitsbergen and Faroe/Iceland. Boldovsky (1939) quotes adolescents from the Barents Sea from 1934-8 while more recently Baranenkova (1960) records them from this area in considerable numbers in 1959. This occurrence he associates with the great inflow of warm water into the southern part of the Barents Sea which took place in that year and carried the fish outside their normal range (see 2.21). Blacker (1966) records considerable numbers of blue whiting to the west of Spitsbergen in 1960-64, and he has related their occurrence with a predominately Atlantic influence as shown by the distribution of benthic indicator species.

At the extremes of their range to the north and west individual specimens have been recorded from east Greenland (Kotthaus and Krefft, 1957), west Greenland (Iversen, 1936; Tåning, 1958) and Georges Bank, off Nova Scotia (Bigelow and Schroeder, 1955). More recently Miller (1966) has reported on further specimens taken off Massachusetts and Nova Scotia - (Fig.2).

At the turn of the century there were several references to their occurrence off the west coast of Ireland (Andrews, 1864; Holt and Calderwood, 1895). More recently they have been recorded from all the Atlantic slope fishing grounds to the west of Scotland and Ireland - George Bligh, Rockall, Porcupine, etc. (Blacker, 1962).

There is little documented information on the distribution of blue whiting in the Bay of Biscay, although Schmidt (1909) states that it is often taken in quantity there by French trawlers, but it has been included in a list of rare fishes off the Basque coast of Spain (Navaz, 1958).

The blue whiting was first identified by Italian research workers (Risso, 1810; 1826; Costa, 1850; Vinciguerra, 1883; etc.). Within the Mediterranean they are found mainly in the west and north, being recorded as common off Algeria (Dieuzeide et al.,1953), off the Costa Brava (Bas and Rubio, 1959), in the Tuscan Archipelago (Matta, 1959) and less frequently within the Adriatic (Soljan, 1948; Zupanovic, 1960). Couch (1878) quotes Risso as saying that it is fished at all times of the year in the deepest portions of the sea in the neighbourhood of Nice, and Aflalo (1904) describes the species as generally common on the westernmost grounds but in some years exceedingly rare on the Italian coast.

Furnestin (1958) recorded several species caught at 250-300 m off Casablanca during a trawling survey of the coast of Morocco, and this probably represents the southernmost limit of its distribution.

2.2 Differential distribution

2.21 Spawn, larvae and juveniles

Spawn: Schmidt (1909) points out that in the north-east Atlantic, where he carried out most of his investigations, the spawning area of blue whiting is a much more southerly one than the total distribution of the population. Spawning takes place in mid-water beyond or on the lower slope of the coastal banks towards deep water to the west of Scotland and Ireland and bounded to the north by Faroe and Iceland. This region he compares with the adult distribution in this area (Fig.3). (See also section on larvae).

Gualini (1938) records blue whiting spawning as early as January in the Ligurian Sea and Schmidt (1909) suggests the possibility of a spawning off the coast of Portugal, perhaps in February. These would suggest that there may be a southern stock which is quite distinct from the north-east Atlantic population. Fraser (1958), however, suggests that

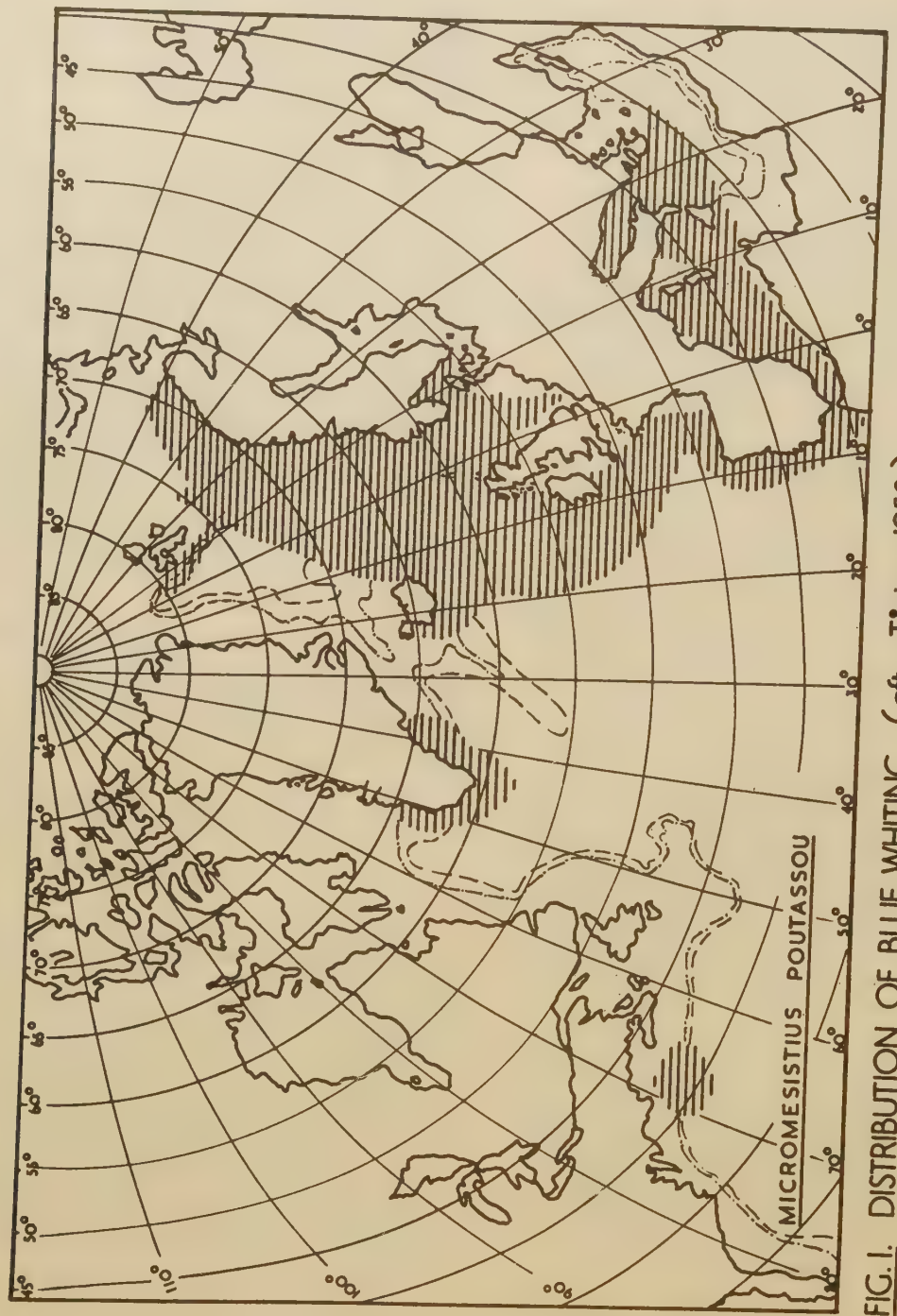

Figure 2. Distribution of blue whiting in the North Atlantic and Mediterranean (Tåning, 1958)

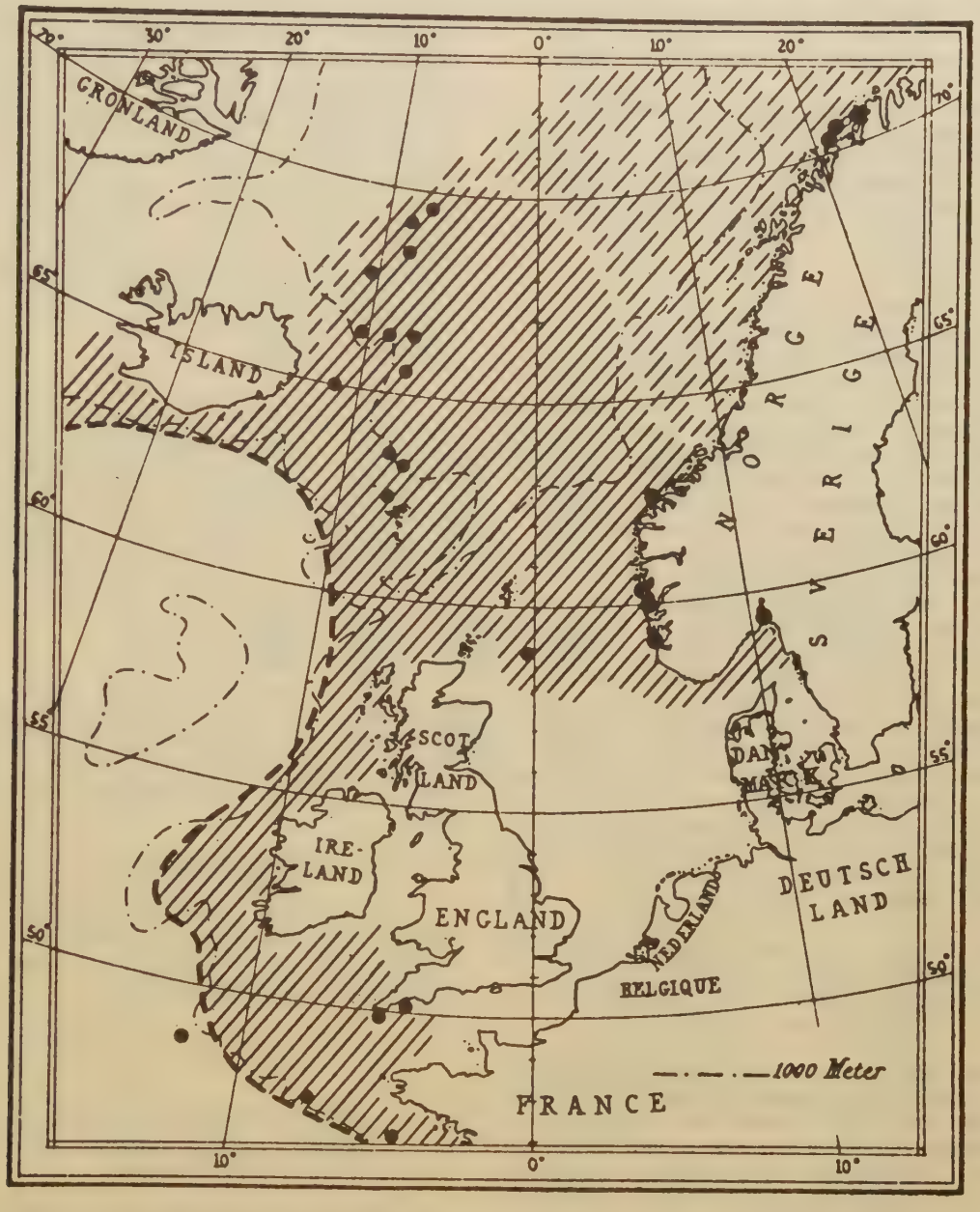

Figure 3. Distribution of blue whiting spawn and adults in the North-East Atlantic. The dark dotted line indicates the north and east boundary of the spawning region whilst the dotted and shaded parts indicate the distribution to the north and east of this (Schmidt, 1909)

the fish caught in the Bay of Biscay, and indeed off the Iberian coasts, could be derived from northern spawnings off the west coast of Ireland, the eggs and larvae being carried south by a branch of the North Atlantic drift. (See also 3.16).

Larvae: Schmidt (1909) quotes a larval distribution similar to that described above for the eggs but found considerable numbers of larvae in the Bay of Biscay as well. Zilanov (1966a) found blue whiting larvae in the Norwegian Sea in June 1961.

The continuous plankton recorder of the Edinburgh Laboratory has regularly covered the area to the west of the British Isles since 1948 and the young stages of blue whiting have been recorded in large numbers over a considerable area to the west of Scotland beyond the 200 m depth contour in the months of March, April and May (Henderson, 1954; 1957; 1961; 1964). Even though this instrument only samples the plankton at a depth of 10 m the numbers encountered and the large area over which they are distributed indicate that there is an enormous spawning here each year (Fig.4). Small numbers of blue whiting larvae have also been recorded from the mid-Atlantic by the Icelandic laboratory, which used plankton nets sampling down to 50 m and their results indicate that the Reykjanes Ridge most probably forms the western limit of the blue whiting spawning area south of Iceland (Magnusson et al., 1965). There is no evidence of spawning off the north-east coast of North America.

Very little information is available from the southern part of its distribution but Fage (1910) caught the larvae in 3,000 m of water off Monaco.

Juveniles: During a cruise by the Scottish Research Vessel "Scotia" to the west of the British Isles in June-July 1955 a number of hauls were made over a large area, using an Icelandic pelagic trawl without sweeps and having a cod-end stretched mesh size of ½ inch. The following observations were made on young blue whiting (Fraser, unpublished): "Blue whiting, 7-14 cm, were taken in a wide area over deep water only, off the edge of the shelf from at least the southern limits of the investigation, approximately 56°30'N, between Rockall and the Hebrides, through the Faroe Channel but fading out some 100 miles north-east of the Wyville Thomson Ridge. The western limits were Rockall and between Lousy and Bill Bailey Banks (approximately 11°W) with a tongue extending northwards over the deep water between Faroe and Iceland. Although these fish were found only over deep water and not over the continental shelf, they were more concentrated in numbers over deep water banks, i.e. water of 200-300 fathoms, and less over the deep water up to 1000 fathoms, in spite of their distribution presumably being dependent upon oceanic water movements, and the fact that the fish themselves were always in the upper 30m". The distribution of these young fish was associated with a strong, well-defined, continuous pelagic trace on the echosounder which showed very little evidence of diurnal migration (Fraser, 1961).

The results of this cruise indicate that the numbers of young blue whiting in the area at that time were very large and from the evidence of the continuous plankton recorder for 1955 (Henderson, 1964) it seems that this was not an exceptional brood year, although fluctuations in numbers from year to year may be considerable.

2.22 Adults

The distribution of adult fish has been described in 2.1 Whether there are any spawning migrations into the area described by Schmidt (1909) in the north-east Atlantic from areas outside is not known.

2.3 Determinants of distribution

Only the northern boundary fell within the region investigated by Schmidt (1909) but he was able to give the following limits for spawning:

Northern limit: the waters south of Iceland

Southern limit: south of the regions investigated (Occurs in the Mediterranean)

Minimum temperature: ca 8°

Maximum temperature: ?

Salinity: not less than 35.25-35.30°/oo

Damas (1909) quotes 6°-9°C.

Blue whiting thrive and spawn in water of high salinity, a condition which is fulfilled in the area Schmidt

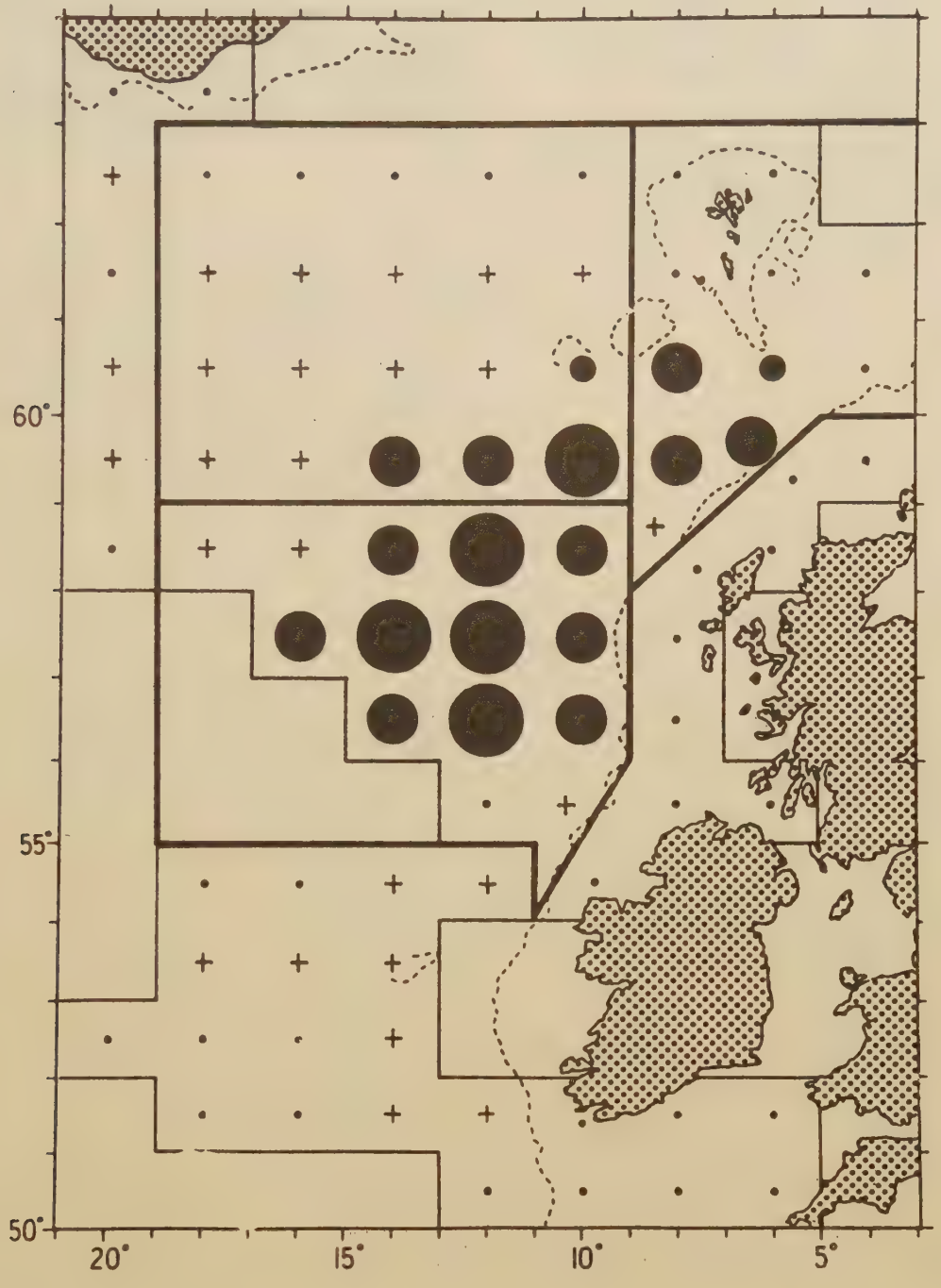

Figure 4. Distribution of young stages of blue whiting in March, April and May for the years 1948-1962. The symbols represent the mean numbers per 10 m^3 during these three months. The dots indicate absence, the crosses show numbers up to 1.0 and the circles, successively, up to 3.0, 10.0 and over 10.0

investigated, i.e. the water west of Scotland, over great depths. It is the species of gadoid whose young stages have the longest pelagic life and this is the reason why it can drift, from the spawning places in the Atlantic, with the Atlantic stream, far up into the Norwegian Sea (Fig. 3).

Fluchter and Rosenthal (1965) found one ripe male and two ripe female blue whiting in the Heligoland Bight in 1964 and, after artificial fertilization of the sexual products, were able to make observations on the freshly hatched larvae. They concluded that these larvae would not have survived at the temperature then occurring in the Bight (3.1-3.8°C) but would have required an environmental temperature of at least 8°C.

3. BIONOMICS AND LIFE HISTORY

3.1 Reproduction

3.11 Sexuality

Blue whiting are heterosexual, but no known external characters distinguish males from females.

3.12 Maturity

Matta (1959) quotes size at first maturity in the Mediterranean as 19.2 cm and 19.4 cm for males and females respectively and Bas (1959) states that they mature in this area at an age of one year. Raitt (1966) shows that fish from Scottish waters and from Faroe reach first maturity at about 20 cm upwards, and at an age of 2-4 years. These results are similar to those recorded by Polonsky (1966) from material collected to the west of Ireland.

3.14 Fertilization

Ova and sperm probably shed freely into the water.

3.15 Gonads

Gualini (1938) gives some information on the maturing gonad.

Table 2 shows data on gonad weights at different sizes and maturity stages in a sample from the Norwegian Deeps, April 1960.

TABLE 2

Data on a sample of blue whiting from the Norwegian Deeps in April 1960 (Raitt, unpublished)

Length (cm)	Gross weight of fish (g)	Gonad weight (g)	Maturity
24	86	4.2	I-III
29	167	12.5	III
31	228	14.3	III
36	325	31.8	IV
37	331	23.1	IV
39	352	20.1	IV
39	442	25.3	IV
40	469	16.7	III
40	477	13.1	III

3.16 Spawning

Spawning is pelagic over considerable depths and, at least in the north-east Atlantic, beyond the edge of the continental shelf.

Gualini (1938) found that blue whiting off Genoa spawned only once a year and were sexually mature from January to May. As already noted, Schmidt (1909) and Henderson (1957) found the larvae from March to May and it is probable that the spawning in the north-east Atlantic is a month or so later than that in the Mediterranean. Hickling (1927) recorded the ovaries as ripe for spawning from February to April on the Irish grounds.

3.17 Spawn

Henderson (1957) has described the characteristics of the egg and records the diameter as 1.1 mm. Fluchter and Rosenthal (1965) give the only description of the egg from artificially fertilized material. (See section 3.21).

3.2 Pre-adult phase

3.21 Embryonic phase

Fluchter and Rosenthal (1965) give data on the embryonic development of artificially fertilized eggs (Table 3) and provide the following description: "The eggs were kept under constant conditions of 8°C and 35°/oo salinity. Four days after fertilization the "primitive streak" became visible; on the sixth day it was clearly marked and went right round the yolk at an angle of 110-120°. The incubation period amounted to about 11-12 days and two to three days before hatching the first black chromatophores could be identified. The larva is about 2.2 mm long at hatching. One day before hatching, the larva has about 9 chromatophores with very considerable branching, shaped like dendrites, and arranged laterally at equal intervals. About 2 days after hatching, small grains of pigment, yellow to orange in colour appear, distributed evenly over the body; only at the posterior end of the yolk sac and shortly before the end of the trunk are accumulations to be found. The yolk sac remains unpigmented and is still very large. Even on the fifth day after hatching, the mouth opening is not visible. The eyes are unpigmented."

TABLE 3

Embryonic development of blue whiting

Date (1965)	Days after fertilization	Stage of development
11 March	0	Fertilization
15 March	4	Primitive streak recognizable
17 March	6	Primitive streak with clearly differentiated head position
20 March	9	Black chromatophores
22-23 March	11-12	Larvae hatch
26 March	14	Appearance of yellow pigment
29 March	17	Mouth not visible, eyes unpigmented

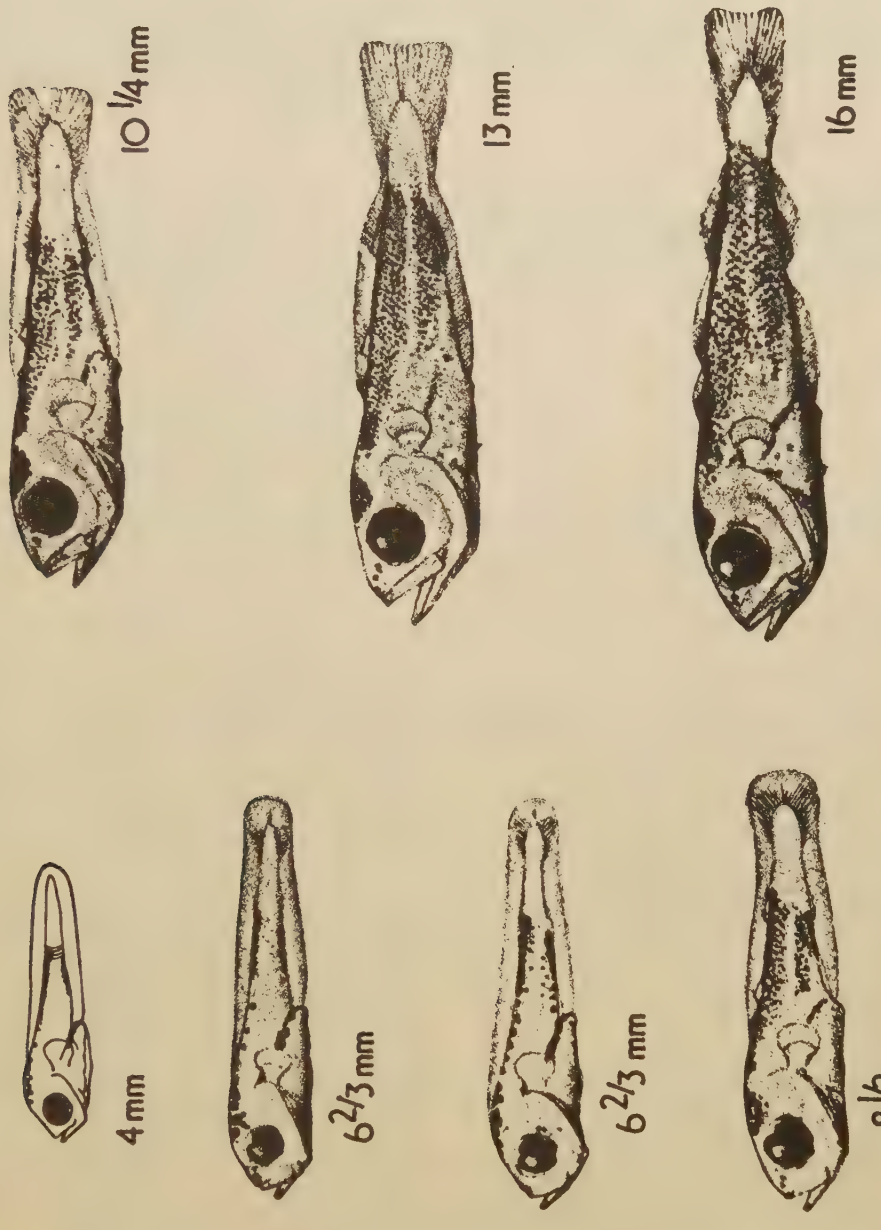

Figure 5. Larvae of blue whiting (Henderson, 1957; Schmidt, 1905)

3.22 Larvae phase

The newly hatched larvae probably measures 2.7-3.0 mm (Henderson, 1957 - but see 3.21 above). Different sizes of larvae have been described by Schmidt (1909) and Henderson (1957) and these are shown in Fig.5 and described in Table 4.

3.23 Adolescent phase

In a fish such as blue whiting which is pelagic throughout its life cycle it is difficult to define the juvenile phase. The distribution of fish 7-14 cm in length has been described in section 2.21.

3.3 Adult phase

3.31 Longevity

Raitt (1966) records fish up to 14 years of age, but notes that the samples he examined pointed to the north-east Atlantic population being, in the main, less than 10 years old. Bas (1963) records few fish over 3 years old in the Italian commercial fishery.

3.33 Competitors

In the ecological environment of the larvae and juveniles, i.e. in the surface layers of waters above considerable depths, there are known to occur large numbers of other pelagic fishes of about the same size, such as myctophids, in particular Benthosema glaciale in the north-east Atlantic (Fraser, personal communication), but their interrelationships with blue whiting are not known.

3.34 Predators

Blue whiting are known to be the principal food of hake off the west coast of Scotland. Hickling (1927) states that they form 37% by weight of all food eaten by the hake and may amount to as much as 70% by weight of the food of hake caught in waters of 250 fathoms depth. He also found a relationship between the occurrence of blue whiting and the catch of hake on exploratory voyages in March-May 1927, when the hake were clearly forming a feeding concentration on shoals of spawning blue whiting.

3.35 Parasites, diseases, injuries and abnormalities

A recent examination of adult blue whiting, 20 from the west coast of Scotland and 20 from Faroe, by Dr Z. Kabata of the Marine Laboratory, Aberdeen, Scotland (unpublished) gave the following results: (see Table 5).

3.4 Nutrition and growth

3.41 Feeding

Hickling (1927) found the blue whiting off the west coast of Ireland were feeding very little during the autumn and winter and that during this time the livers were abnormally large. From April to September feeding was intensive; the liver was small and the sexual organs were reduced. The stomach contents of 170 fish examined in October 1926 averaged only 0.7 gm per fish whereas in July 139 blue whiting contained, on average, 2.6 gm of food per stomach.

3.42 Food

The food of blue whiting from the Mediterranean has been described by Issel (1931), Brian (1936) and Dieuzeide (1960), who confirmed that the principal diet consisted of crustaceans (euphausids and shrimps), small fishes (myctophids, gobies and small gadoids - Gadiculus) and, less frequently, small cephalopods.

Hickling (1927) found the stomach contents of adult blue whiting from west of the British Isles to consist almost entirely of krill (Meganyctiphanes) in April but in the summer there was a change to a fish diet, the main species recorded being young blue whiting, Gadiculus and myctophids. An analysis of the stomachs of blue whiting caught at the Faroes in the summers of 1960 and 1961 showed them to be feeding mainly on sandeels (Raitt, unpublished). Zenkevitch (1963) records their food in the Barents Sea as consisting entirely of pelagic crustacea.

3.43 Growth rate

Average lengths of blue whiting at different ages from the Mediterranean and the north-east Atlantic are shown in Table 6. The rates of growth are remarkably consistent throughout the geographical range and growth appears to be very rapid up to two years of age and

considerably slower thereafter.

Raitt (1966) has fitted the Von Bertalanffy growth equation $L_t = L_\infty (1 - e^{-K(t-t_o)})$, by the method of maximum likelihood, to the data on mean lengths for successive ages from the west coast of Scotland in April/May 1965 and from Faroe in May/June 1965. The values of the growth parameters obtained are shown in Table 7 and compared with the parameters calculated for Mediterranean samples from the data of Matta (1959) and Bas (1963).

TABLE 4

Development of larval characteristics with growth (see Fig.5)
2½ mm after Fluchter and Rosenthal (1965)
4 mm after Henderson (1957), all others after Schmidt (1905)

Length	Characteristics
2½ mm	Eyes unpigmented, accumulations of pigment only at posterior end of yolk sac and shortly before the end of the trunk. Mouth opening not visible.
4 mm	Occipital pigment of 6-10 chromatophores. One or two faint pre-anal chromatophores. Eyes fully pigmented. Notochord straight.
7 mm	Notochord still straight. Faint indication of rays in caudal fin.
8½ mm	Notochord bent slightly upwards. Indication of inter spinous regions in all unpaired fins. Dorso and ventro-lateral pigment now very dense and well marked.
10¼ mm	Notochord bent strongly upwards. Fin rays still indistinct. A narrow medio-lateral belt is still free of pigment.
13 mm	Free end of the notochord almost entirely reduced. Caudal fin slightly concave. ca ID5, IID6, IIID16 rays. ca IA25, IIA16. Anus lies under ID.
16 mm	ca ID7, IID10, IIID20, IA27, IIA21. No pigment on fins. Pigment on sides extends almost to the beginning of the caudal fin.
21 mm	Fins unpigmented. Abdominal region has already the first weak signs of a silvery sheen.
25½ mm	Caudal fin deeply forked. Unpaired fins quite separated.
32 mm	Body now has greater height in front of anus. Fins practically without pigment. ID12, IID12, IIID23, IA37, IIA27.

TABLE 5

Parasites of blue whiting (Kabata, unpublished)

Parasite	Organ infected	W.Coast of Scotland		Faroe	
		% of fish infected	Incidence per fish	% of fish infected	Incidence per fish
Bimeria sp.	Liver	87.5	mod.	100	mod.
Zschokkella hildae	Urinary ducts	4	mod.	-	-
Octodactylus minor	Gills	33	1-2	100	mod.
Bucephalopsis gracilescens; metecercaria	Cranial cavity	100	2-20	100	2
Stephanostomum caducum	Pyloric caeca	8	1	-	-
Derogenes varicus	Gills, stomach				
Contracaecum aduncum; larva IV	Pyloric caeca Stomach, pyloric caeca, fore, mid and hindguts	8	1	100	2
Contracaecum sp; larvae	Liver, hindgut, surface pyloric caeca	16	14-70	-	-
Anisakis sp; larva	Mesenteries, liver, muscle	100	2-42	100	68
Porrocaecum decipiens; larva	Liver surface	25	1	100	14
Ascarophis sp.	Stomach	-	-	100	2
Unidentified larval nematodes		4	1-2	-	-
Trypanorhynch larvae	Stomach, intestine	4	6	-	-
Plerocercoid larvae	Fore, hindgut	8	1	-	-
	Hindgut	12	3-7	100	1

TABLE 6

Lengths of blue whiting, at various ages, from the Mediterranean and north-east Atlantic; age (in years) determined from otoliths

Area	Time of sample	0	1	2	3	4	5	6	7	8	9	10+	Authority
Tuscan Archipelago	Oct.57-Feb.58	15	20	23	25	26	27	-	-	-	-	-	Matta (1959)
West Mediterranean	1951-58	-	19	23	25.2	-	-	-	-	-	-	-	Bas (1963)
West Coast Scotland	Apr.May 1965		18.9	23.4	25.9	27.2	28.1	29.2	31.4	33.3	34.2	35.0	Raitt (1966)
Faroe	May-June 1965		19.5	23.2	25.4	26.2	28.2	28.6	29.8	30.5	31.8	34.2	Raitt (1966)
Iceland	May 1962		20.4	23.6	25.4	26.8	28.3	29.1	30.0	30.6	32.2	34.8	Raitt (1966)
Iceland	May 1927	-	18	24	25.6	29.5	-	-	-	-	-	-	Saemundsson (1929)

TABLE 7

Growth parameters of blue whiting from different areas

	Tuscan Archipelago	Western Mediterranean	West Coast of Scotland	Faroe
L_∞	28.1	27.9	39.9	33.4
K	0.48	0.60	0.15	0.23
T_o	-1.60	-0.91	-3.51	-2.94

Increases in gross weight (body + guts) with length, however, are not so consistent (Table 8) and the Mediterranean fish are heavier than the north-east Atlantic specimens at lengths of 20 cm and over.

Data from Matta (1959) and Raitt (1966) confirms that females are in general larger than males and also heavier. No information is available on seasonal growth rate.

3.5 Behaviour

3.51 Migrations and local movements

The distribution of blue whiting to the north of their spawning area has been attributed to the influence of the North Atlantic Drift. (See 2.3 and Fig.3).

3.52 Schooling

Several references occur of blue whiting shoals being seen at the surface. Holt and Calderwood (1895) record a large shoal at the surface and Dunn (in Day, 1880) describes how in 1861, 1871 and 1881 young blue whiting came in enormous shoals to the coast of Cornwall, the fish "leaping over each other to devour the young herrings which were plentiful in the sea".

In the open Norwegian Sea pelagic schools of blue whiting have been frequently observed more or less as scattered formations but sometimes also in rather dense concentrations (Østvedt, 1961).

TABLE 8

Weight (in g) in relationship to the length of the fish

Length (cm)	Tuscan Archipelago (Matta, 1959)	Western Mediterranean (Bas, 1963)	North East Atlantic (Raitt, unpublished)
11	-	-	12.0
2	-	-	12.5
3	-	-	14.7
4	-	-	17.8
5	-	-	21.5
6	-	-	25.3
7	30.2	-	30.0
8	39.0	-	35.5
9	44.5	40.0	40.4.
20	51.7	-	44.7
1	59.0	-	52.9
2	66.9	-	71.0
3	75.6	80.0	68.9
4	86.9	-	77.5
5	100.1	109.0	84.3
6	108.7	-	96.3
7	122.1	-	105.5
8	136.5	-	117.3
9	161.0	-	124.9
30	-	-	143.8
1	-	-	161.4
2	-	-	183.7
3	-	-	192.8
4	-	-	210.7
5	-	-	269.3
6	-	-	284.0
7	-	-	325.0
8	-	-	356.0
9	-	-	387.0
40	-	-	473.0

4. POPULATION

4.1 Structure

4.11 Sex ratio

TABLE 9

Sex ratio of blue whiting samples

Region	% Male	% Female	No. of fish	Authority
Iceland	35	65	113	Raitt (1966)
Faroe	46	54	106	" "
West Coast Scotland	41	59	170	" "
Tuscan Archipelago	41	59	358	Matta (1959)
" "	36	64	658	" "
" "	42	58	797	" "
" "	54	46	109	" "

The data of both Raitt and Matta came from research ship samples. It appears that either sex can predominate and there is no evidence of segregation.

4.12 Age composition

Percentage age composition from the Mediterranean and north-east Atlantic are shown in Table 10. Once again the information is from research ship sampling and the difference between the two areas is clear, there being a far greater proportion of older fish from the Atlantic. The maximum age recorded is 14 years from the Norwegian Deeps (Raitt, 1966).

Bas (1963) states that in the western Mediterranean, fish first enter the fishery at one year of age.

4.13 Size composition (see Table 11)

Matta (1959) gives separate length frequencies for males and females showing that there were more females amongst the larger size groups in his sample.

Size at maturity: see section 3.12

- Maximum size

Matta (1959) gives 35 cm as the largest fish in his samples from the Tuscan Archipelago while Dieuzeide (1960) quotes a 36 cm specimen from the coast of Algeria. Bas (1959), however, states that specimens over 35-40 cm are very uncommon in the commercial catches from the Mediterranean. Raitt (1966) records, from samples taken in the north-east Atlantic, that the largest specimen examined was a 42 cm fish from the Norwegian Deeps.

- Maximum weight

Raitt (unpublished) has recorded gross weights of 477 gm from a 40 cm female and 294 gm from a 35 cm male in a sample from the Norwegian Deeps.

- Length and weight relationship

Matta (1959) derived the following relationship for the Mediterranean:

$$W = 0.007468 \times L^{2.9701}$$

and Raitt (1966) obtained the following for fish from the north-east Atlantic:

$$W = 0.009247 \times L^{2.8656}$$

4.2 Abundance and density

4.21 Average abundance

No estimates of total stock size so far have been given. See,however, 2.21.

TABLE 10

Percentage age composition of blue whiting samples

Area	Time	0	1	2	3	4	5	6	7	8	9	10+	Authority
Tuscan Archipelago	Oct.57-Feb 58	9.1	38.9	23.3	21.3	4.4	3.0	-	-	-	-	-	Matta (1959)
West Coast Scotland	Apr.-May1965	-	30.1	9.1	4.9	11.1	23.5	13.7	3.7	1.8	1.7	0.4	Raitt (unpublished)
Faroe	May-June 1965	-	1.5	7.8	11.8	14.7	24.7	24.0	5.8	8.9	0.9	0.1	Raitt (unpublished)
Iceland	May 1962	-	4.0	11.4	9.5	8.7	26.5	20.4	7.8	7.5	3.4	0.9	Raitt (unpublished)

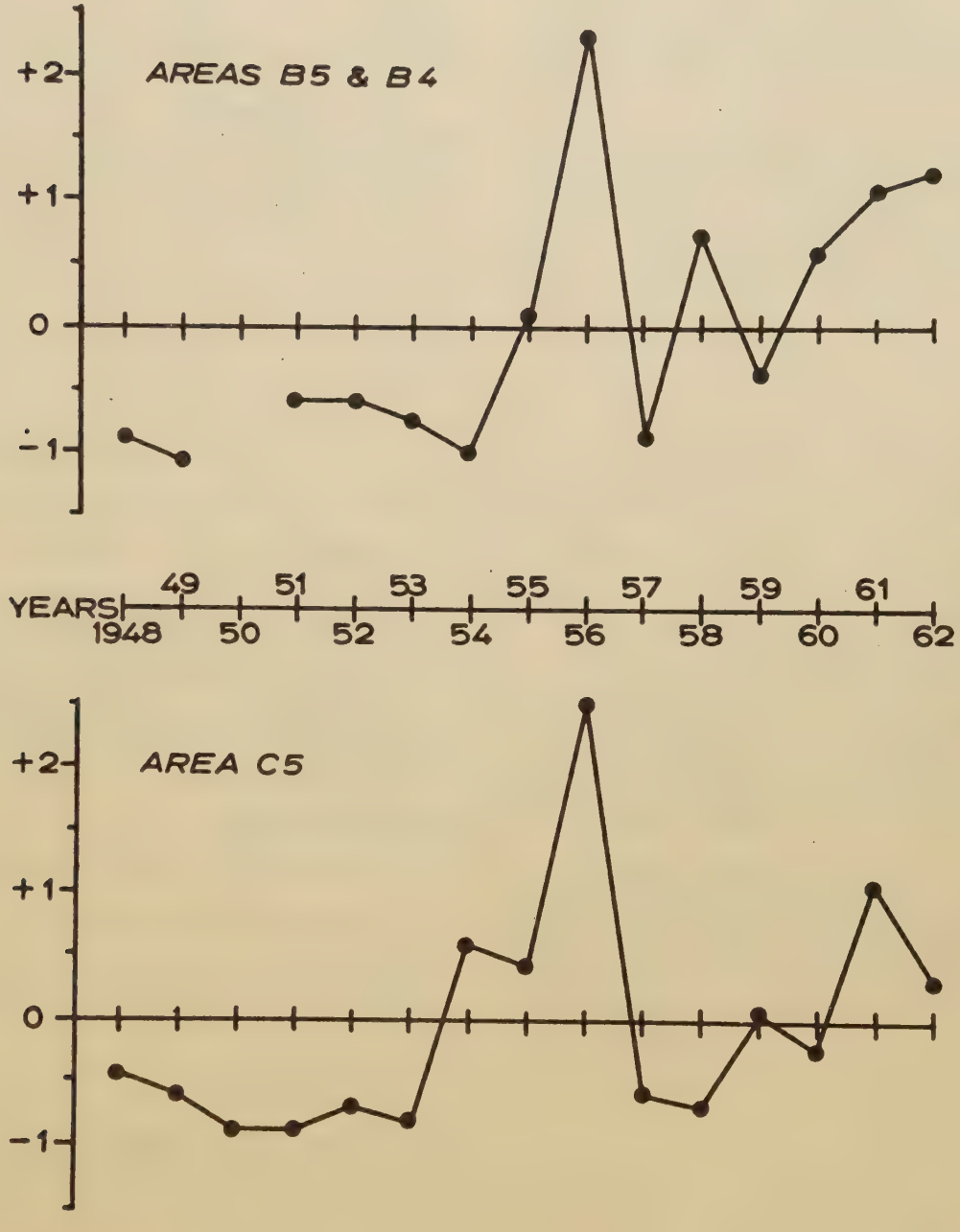

Figure 6. Abundance of blue whiting larvae

4.22 Changes in abundance

Henderson (1964) has recorded fluctuations in the abundance of larval blue whiting off the west coast of Scotland (Fig.6). During the 6 years prior to 1954 these young fish were rather scarce and there were no very striking fluctuations, whereas from 1955 onwards the general level of abundance was appreciably greater and fluctuations from year to year were much more marked. Area C5 is off the west coast of Scotland (see Fig.4) and areas B5 and B4 are to the north of it. It should also be noted that the mean overall abundance in area C5 was 5 times that in B5 and B4.

4.6 The population in the community and the ecosystem

Blue whiting is a pelagic fish spawning in mid-winter over considerable depths. The conditions required for spawning (i.e. temperature, salinity) are noted in section 3.16.

It is probable, at least in the north-east Atlantic, that myctophids are the only species which could be seriously competing for space or food (see section 3.33). Blue whiting are the principal food, in this area, of the deep water hake but it is possible that if more information were available they would also be shown to be an important food item for other predators such as squid, etc.

TABLE 11

Size composition of blue whiting

Area	Time of sample	Length range (cm)	Modes (cm)	Authority
Tuscan Archipelago	Feb.1958		22/28/31	Matta (1959)
Western Mediterranean	1958	14-32	18/21/27	Bas (1963)
West Coast of Scotland	April-May 1965	16-39	18/25/28/33	Raitt (unpublished)
Faroe	May-June 1965	17-35	18/26/29	" "
Iceland	May 1962	15-36	19/22/27/32	" "
Iceland	May 1927	10-35	18/24/26/29	Saemundsson (1929)

5. EXPLOITATION

5.1 Fishing equipment

5.11 Gear

At present only Spain lands blue whiting in significant quantities. Lesser quantities are marketed in Italy and in recent years the proportion of blue whiting in the unspecified category of the northern North Sea and Skagerrak industrial landings is believed to have risen. All the above fisheries employ bottom trawls.

5.12 Boats

Wooden and steel trawlers 60-90 ft. are employed in the industrial fisheries in the North Sea. In the Mediterranean the Spanish trawlers are mainly wooden and of a similar size but the gear is usually hauled over the stern.

5.2 Fishing areas

5.21 General geographic distribution

The main Mediterranean fisheries occur on the Catalan coast (east coast of Spain) and in the Tuscan Archipelago (west coast of Italy). The European fisheries which land blue whiting as a by-catch are confined to the Skagerrak, Norwegian Deeps and Norwegian Sea.

5.22 Geographic ranges

See 2.1

5.23 Depth ranges

In the Catalan fishery blue whiting are caught at depths in excess of 200 metres.

5.24 Conditions of the grounds

Most areas exploited at present are just beyond the edge of the continental shelf.

5.4 Fishing operations and results

5.43 Catches

Annual landings from the Mediterranean are shown in Fig.7 for the years 1946-1964 (FAO, 1965). Yields from individual fishing grounds are not available.

Since there is no special fishery in the north-east Atlantic the landings of this species are grouped, in the fisheries statistics, with several others under the categories "various gadiforms" and "various other species" which usually include other lesser known gadoids and silver smelts caught and landed in the industrial fisheries. Table 12 shows the Norwegian landings of species protected under the provisions of the 1946 Overfishing Convention, plus "various other species" from the industrial fisheries for herring, sandeel and Norway pout (data from the proceedings of the North East Atlantic Fisheries Commission-NEAFC). It can be seen that not only have the total landings risen in recent years but so has the proportion of blue whiting.

Poulsen (1946) states that they form a significant proportion of the by-catch of the Danish fishery for deep sea prawns in the Skagerrak and Kattegat and in recent proceedings of the NEAFC it is stated that they form 9% of the by-catch from this fishery, but information on the quantity caught is not available.

Russian research vessels have landed significant quantities from the Porcupine and Rockall Banks to the West of Britain. During one cruise in 1965 the research scouting vessel "Atlant" caught 150 tons (Zilanov, b, in press). The potential in this area has been briefly discussed by Raitt (1966).

TABLE 12

Landings of blue whiting, by Norway, as by-catch from industrial fisheries

North Sea and Skagerrak
(Data from proceedings of North East Atlantic Fisheries Commission)

	Total landings of Annex II species and "various other species" (metric tons)	Probable percentage of blue whiting in catch
1961	1,167	?
1962	1,539	35
1963	3,491	67
1964	10,091	65

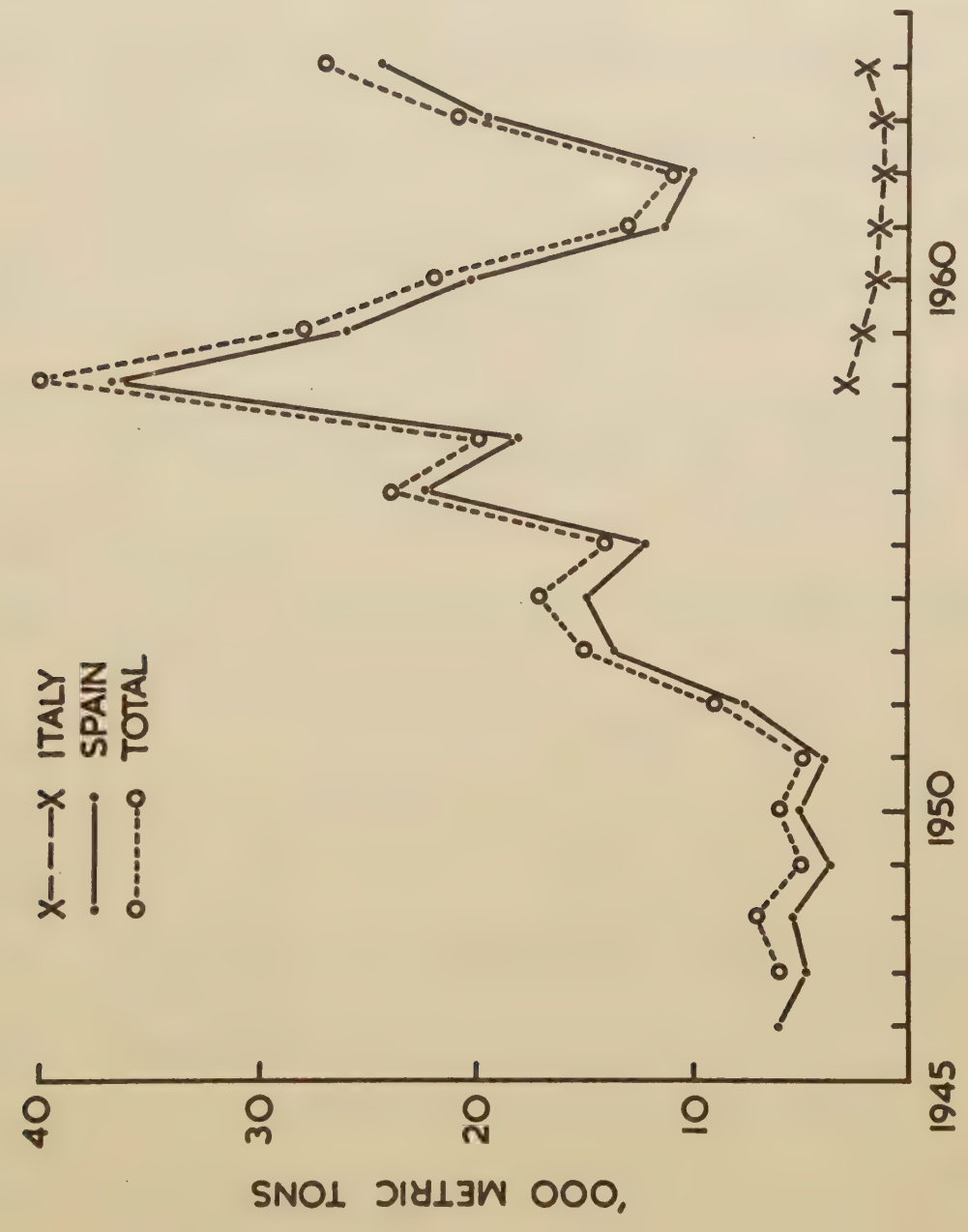

Figure 7. Blue whiting landings from the Mediterranean 1946-1964

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